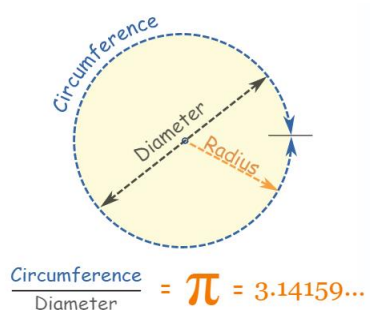# Assignment #8 (Due: 31-Mar-2021)

A few days back, March 14th, we celebrated the '**Pi Day**': 3.14

The definition of π is: The Circumference divided by the Diameter of a Circle.

π is an irrational number, approximately equal to:3.14159265358979323846…
The digits go on and on with no pattern.
π has been calculated to fifty trillion decimal places and still there is no pattern to the digits.

A quick and easy approximation for π is 22/7.   22/7 = 3.1428571...
But, 22/7 is not exactly right. In fact, π is not equal to the ratio of any two numbers (it is irrational).

Here is π with the first 100 decimal places:
> 3.1415926535897932384626433832795028841971693993751058209749445923078164062862089986280348253421170679...

Calculating π

The calculation of π has been revolutionized by the development of techniques of infinite series, especially by mathematicians from Europe in the 16th and 17th centuries.

Here are a few techniques for calculating π:

Viete's Series
The first infinite sequence discovered in Europe was an infinite product, found by French mathematician **François Viète** in 1593:

$$\frac{2}{\pi} = \frac{\sqrt{2}}{2} \cdot \frac{\sqrt{2+\sqrt{2}}}{2} \cdot \frac{\sqrt{2+\sqrt{2+\sqrt{2}}}}{2} \cdots$$

Wallis's Series

The second infinite sequence, found in Europe by **John Wallis** in 1655, was also an infinite product:

$$\frac{2}{1} \cdot \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdot \frac{6}{7} \cdot \frac{8}{7} \cdot \frac{8}{9} \cdot \ldots = \frac{\pi}{2}.$$

Leibniz's Series

Madhava of Sangamagrama, an Indian mathematician, formulated a series that was rediscovered by Scottish mathematician **James Gregory** in 1671, and by **Leibniz** in 1674:

$$\pi = \frac{4}{1} - \frac{4}{3} + \frac{4}{5} - \frac{4}{7} + \frac{4}{9} - \frac{4}{11} + \frac{4}{13} - \cdots$$

Nilakantha's Series

An infinite series for **π** published by **Nilakantha**, an Indian mathematician, in the 15th century is:

$$\pi = 3 + \frac{4}{2 \times 3 \times 4} - \frac{4}{4 \times 5 \times 6} + \frac{4}{6 \times 7 \times 8} - \frac{4}{8 \times 9 \times 10} + \cdots$$

Write Python functions to calculate the value of π by using the above series. Choose a number of iterations (100,000 or 500,000 or 1,000,000) for each series, as you see it fit.

The output should be as follows:

Series	Iterations	Calculation Time	π **Value** (up to 50-digit precision)
Viete			
Wallis			
Leibniz			
Nilakantha			